NWS Storm Based Tornado Warning Polygons During QLCS Events

Operational considerations geared toward improving Tornado Warning services and possibly public complacency issues

---

by

Chris Noles - WFO Paducah, KY
Assistance provided by Christine Wielgos - WFO Paducah, KY

Comments from a CNN.com article - Joplin, MO Tornado

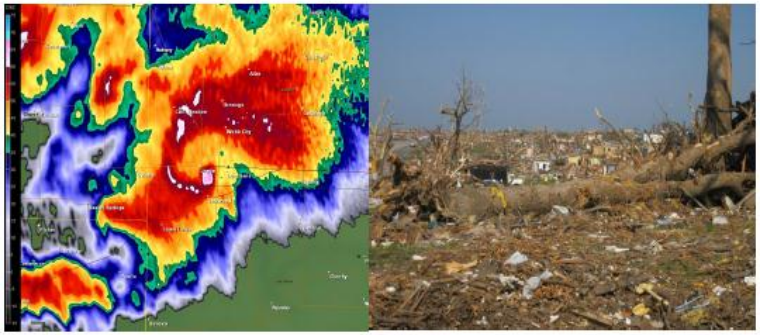
"We need to ask ourselves, what can we do to protect Americans? I have to say, it's not enough. We have to do more." - Jack Hayes (Assistant Administrator for Weather Services Director, National Weather Service)

The staff at WFO Paducah, KY agrees, and we want to begin the process of "doing" more.

Internal CRH assessment of the Joplin, MO Tornado

NWS Central Region Service Assessment

Joplin, Missouri, Tornado – May 22, 2011



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service, Central Region Headquarters
Kansas City, MO

July 2011

- **Finding #2e:** 76% of all NWS tornado warnings, in their totality, are false alarms. 24% of all tornado warnings are eventually associated with an observed tornado.

- **Recommendation #2:** To improve severe weather warning response and mitigate user complacency…

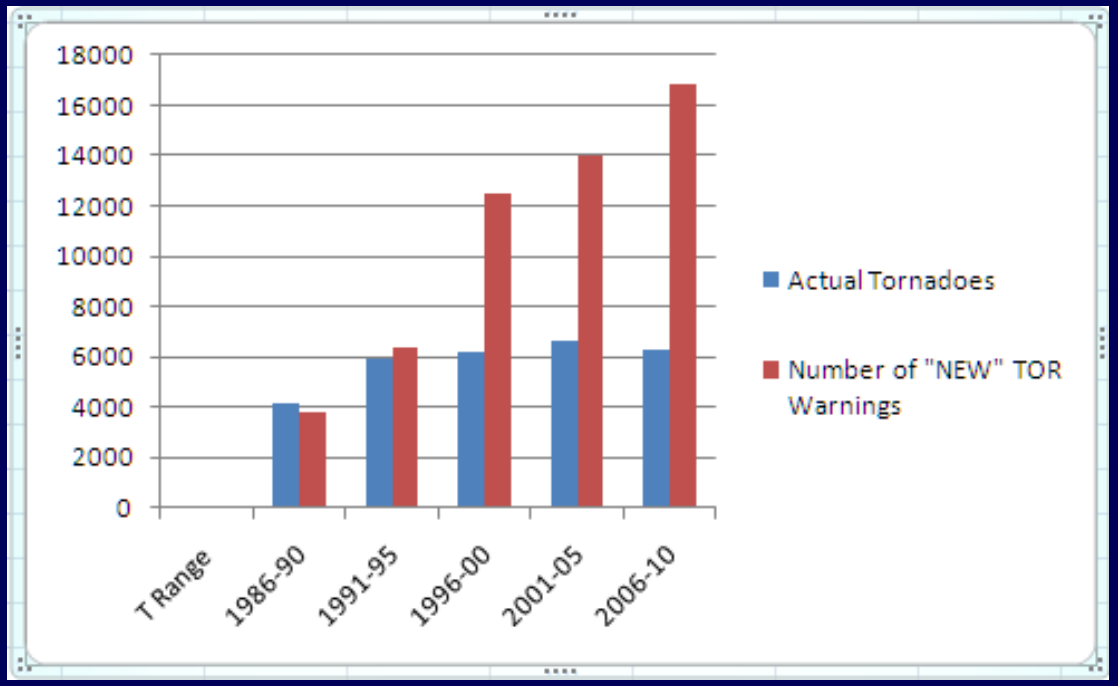
Negative Feedback sent to NWS regarding Tornado Warnings (John Ferree - OCWWS Severe Storms Services)

Too Many Tornado Warnings? Comments to weather.gov (April 29-May2)

- *"Your tornado warnings are of no value anymore. You announce a warning everytime there is rotation and people get to where they have no faith in the system"*
- *"All of the warnings lately are doing nothing but scaring the crap out of the people who are too dumb to know the difference."*
- *"Crying wolf to early and to often will just make people complacent and not respond to threats when they happen."*

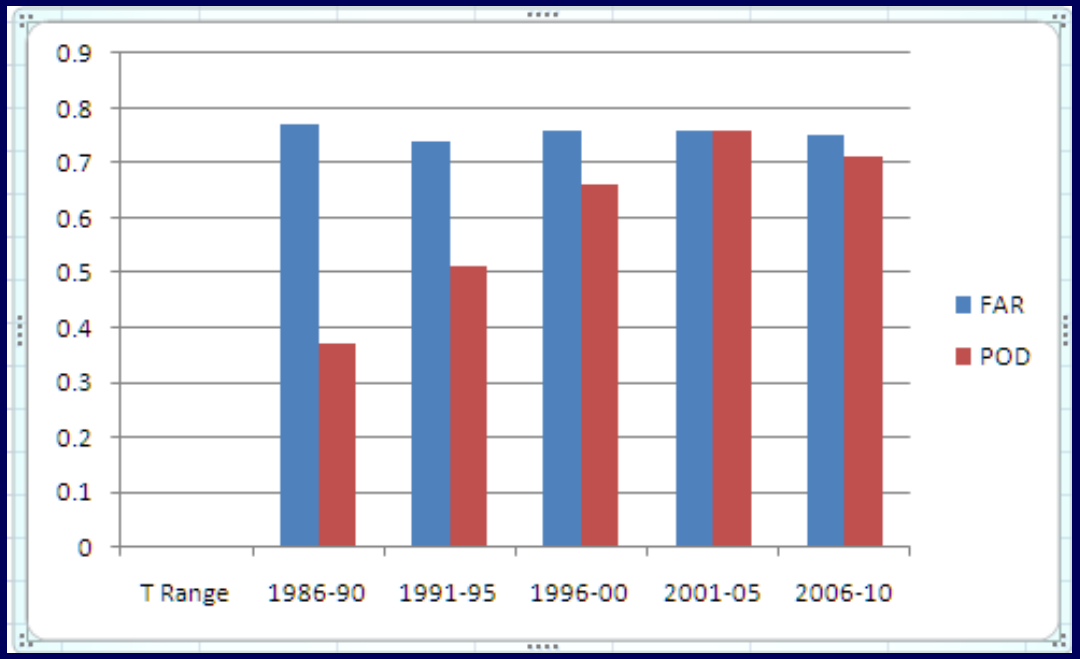
Tornadoes vs. Warnings

Number of Tornadoes vs. Number of “New” Tornado Warnings 1986-2010 (SPC and NWS Verification)



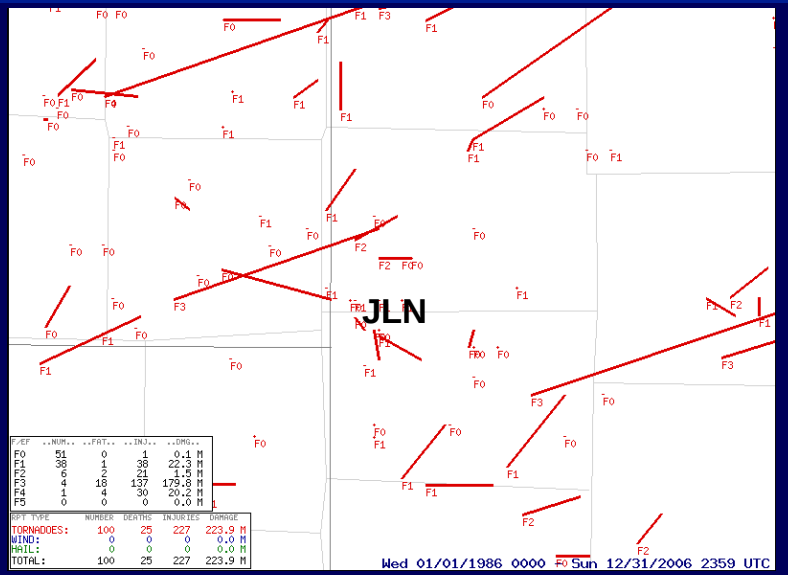
Performance

NWS Probability of Detection (POD) and False Alarm Ratio (FAR) past 25 years

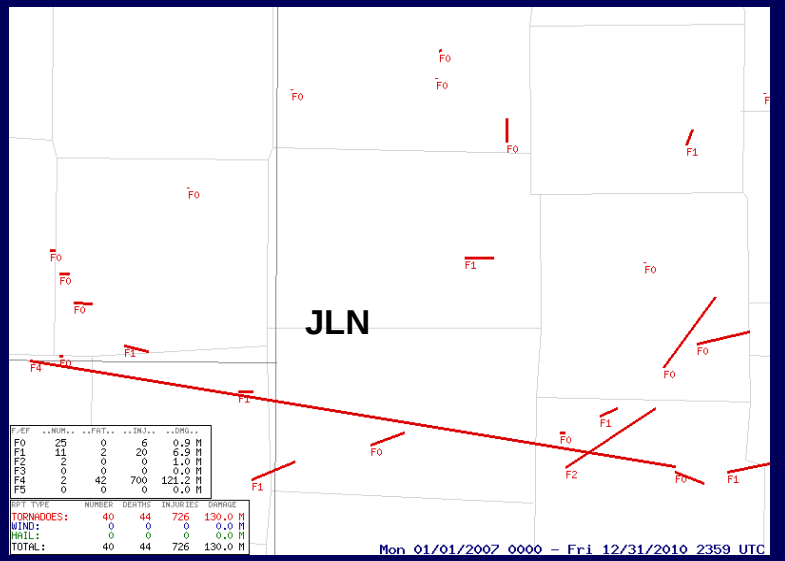


Jasper County, MO Tornado Warning History since 1986 County and Storm Based

From 1986-2006...
Number of “new” Tornado Warnings for Jasper Co., MO
= 26 (in 20 years)



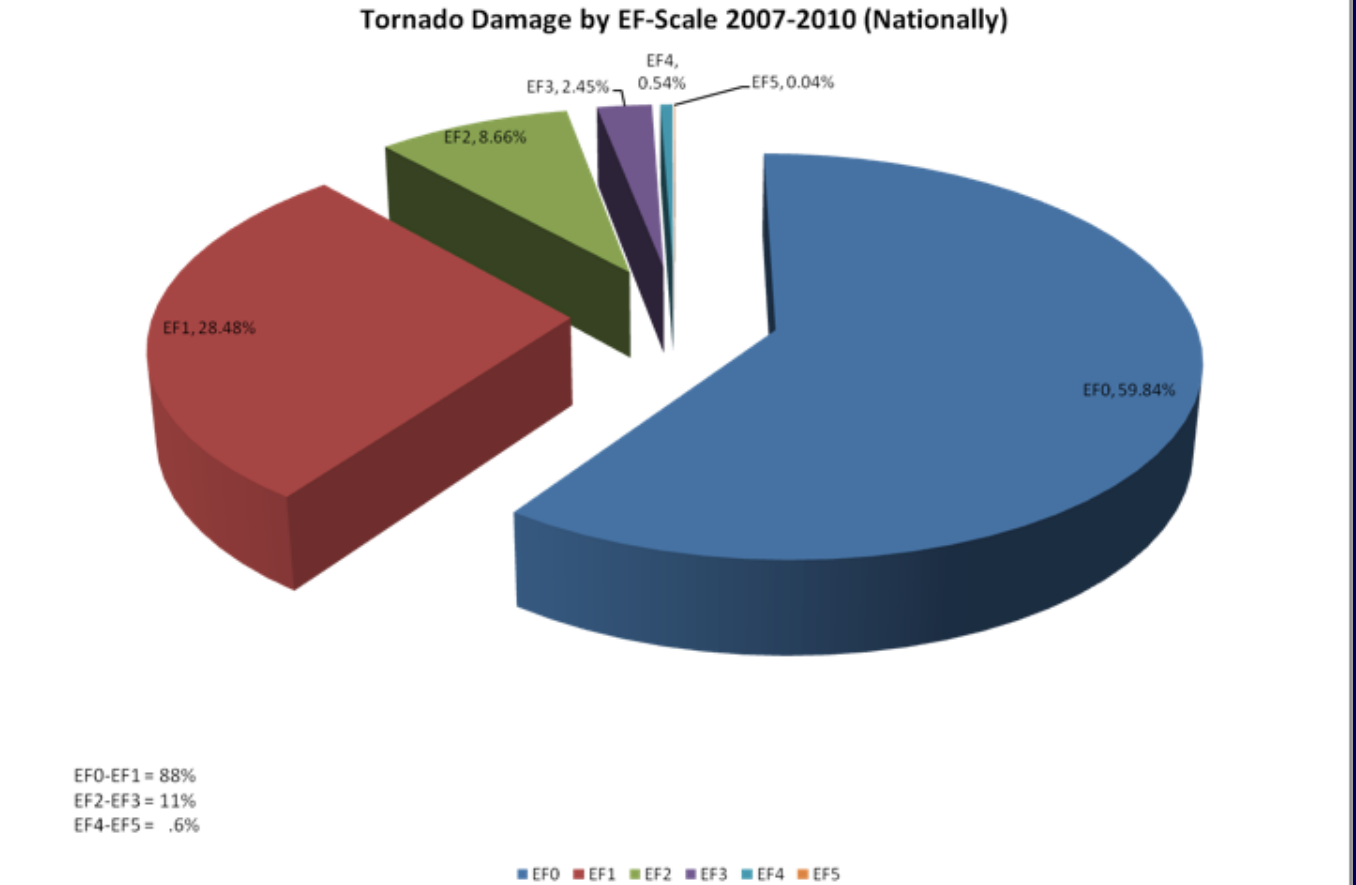
From 2007-2010...
Number of “new” Tornado Warnings for Jasper Co., MO
= **28 (in 4 years)**



Break down of Tornadoes 2007-2010 - Dan McCarthy (MIC IND)

88 percent of Tornadoes were EF0-EF1 vs. 12 percent ranked EF2-EF5 (defined as significant by SPC)

Numbers are similar for the period 1986-2010

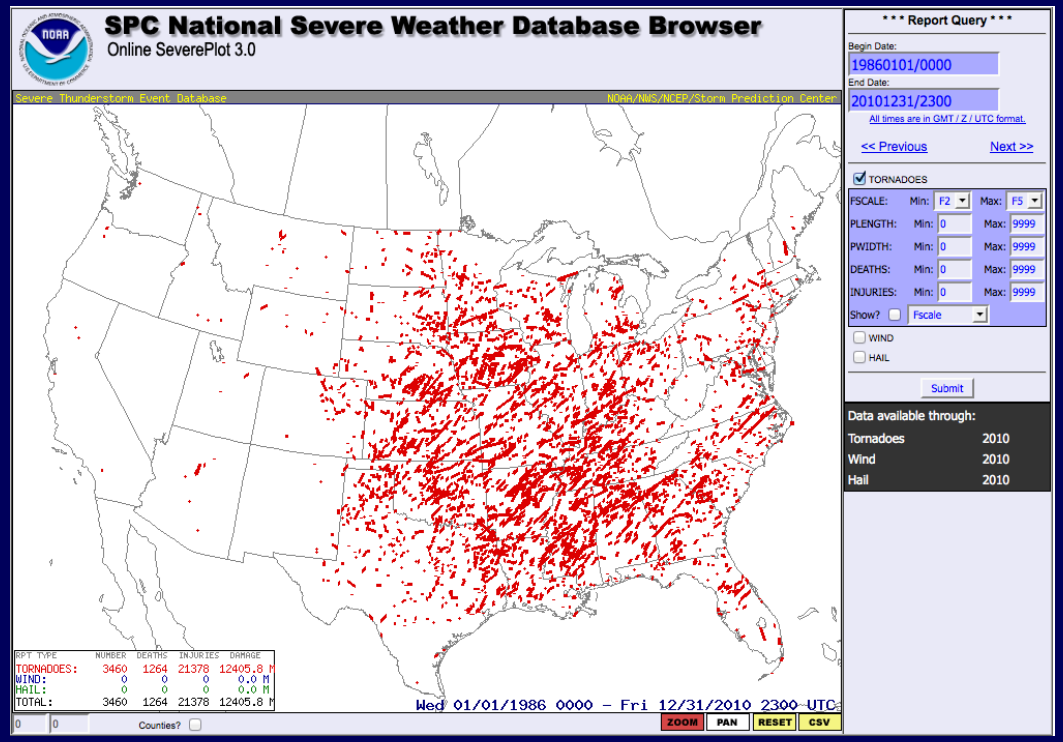


1986-2010 Tornado Related Deaths and Injuries

Deaths and Injuries from Tornadoes - 1986-2010

Deaths
F/EF0/1 - 107 (8%)
F/EF2/5 - 1264 (92%)
f/ef0 – less than 1%

Injuries
F/EF0/1 - 3494 (14%)
F/EF2/5 - 21378 (86%)
f/ef0 – around 1%



SPC Severe Weather Database Browser - Online SeverePlot v3.0

Characteristics and Estimated Warning Success Rates of Significant Tornadoes from QLCS and Supercells in the Southeast U.S.

Steven E. Nelson – NOAA/NWS Atlanta/Peachtree City, GA
Garrett D. Combs – Lyndon State College, Lyndonville, VT

Turning our attention to weaker Tornadoes and Quasi Linear Convective Systems (QLCS) events

- Per the authors research, a little over 20 percent of significant (EF2 or greater intensity) tornadoes were associated with QLCS events. This means nearly 80 percent of QLCS events produced “weaker” tornadoes from EF0 to EF1

- Less than 1 percent of fatalities in the past 25 years were associated with F/EF0 tornadoes. Roughly 7 percent were with F/EF1, many of which occurred with higher end F/EF1 tornadoes.

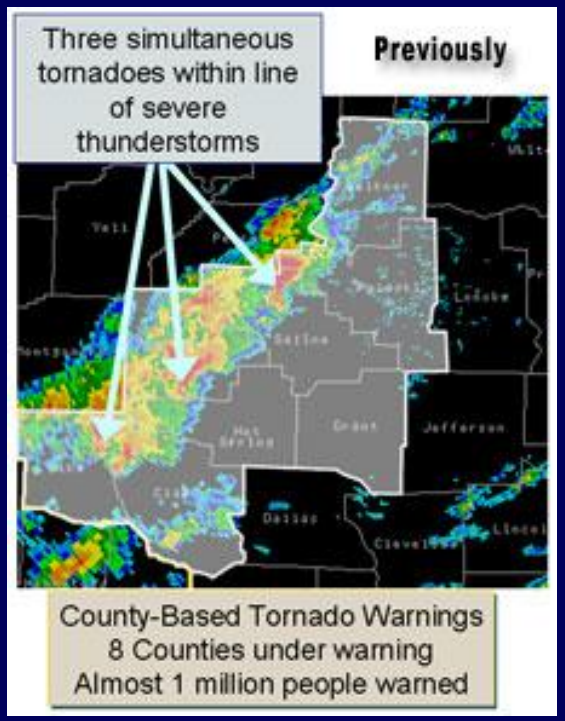
Thoughts / Questions...

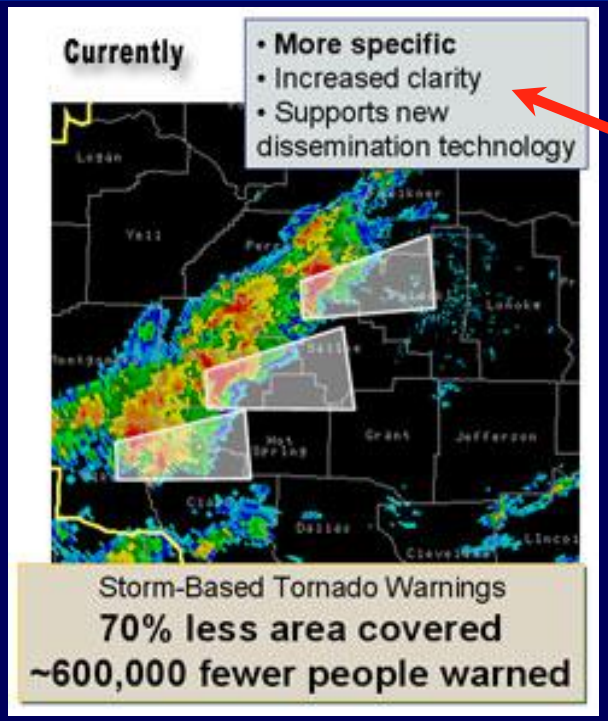
With over 85 percent of our tornadoes nation wide rating EF0 and EF1, while only 20 percent of our significant tornadoes are associated with Linear Convective Systems..

..is it conceivable that Tornado Warning accuracy and timeliness challenges with QLCS events contribute to both false alarm and increased public complacency?

Promoting Storm Based Warnings

http://www.weather.gov/sbwarnings/



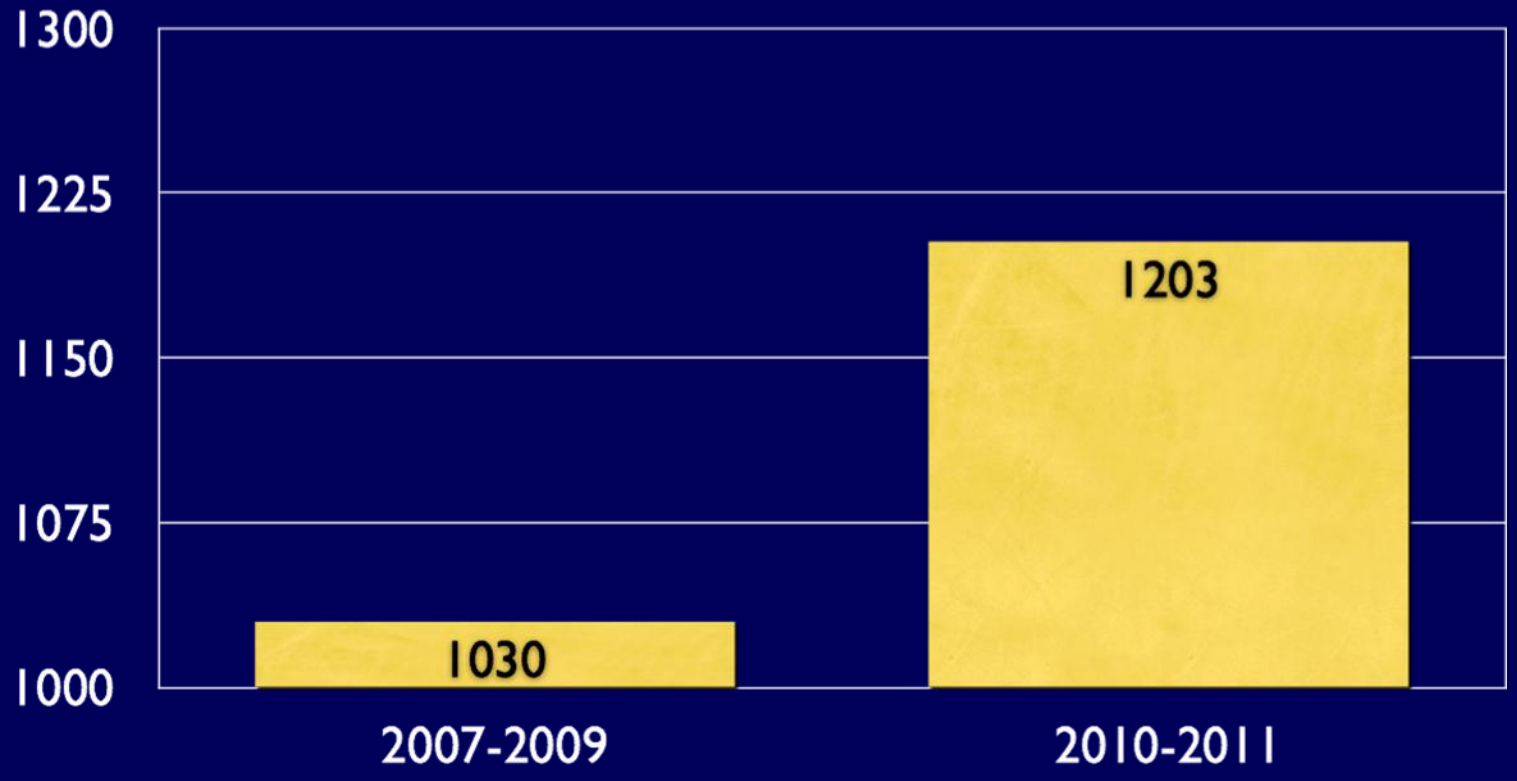


Launched Oct 1, 2007

Storm-Based Warnings **show the specific meteorological or hydrological threat area and are not restricted to geopolitical boundaries. By focusing on the true threat area, warning polygons will improve NWS warning accuracy and quality.**

NWS National Average Tornado Warning Polygon Size

Average size of all NWS Tornado Warning Polygons from Oct 1, 2007 to June 30, 2011 (sq km)



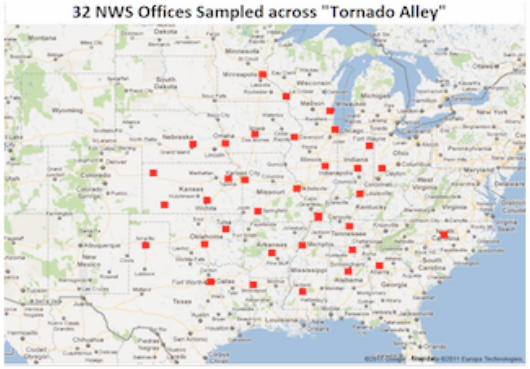
Wide range of Tornado Warning Polygon Sizes - Courtesy of Iowa State University (IEM Cow)

Oct 1, 2007 through June 30, 2011

Top 10 Largest for WFO: ALL

Date Issued	Size (sq km)	WFO	Phenomena
2010-06-17	12091	FGF	Tornado Warning 41
2010-06-17	11657	FGF	Tornado Warning 33
2008-01-08	10309	SGF	Tornado Warning 60
2010-06-17	9022	FGF	Tornado Warning 45
2010-12-31	8314	LSX	Tornado Warning 88
2008-06-04	8252	SGF	Tornado Warning 138
2008-06-04	7927	SGF	Tornado Warning 136
2011-05-26	7909	IND	Tornado Warning 72
2010-06-17	7773	FGF	Tornado Warning 30
2011-05-25	7580	PAH	Tornado Warning 157

Averaged largest 5 TOR polygons from 32 WFO's sampled



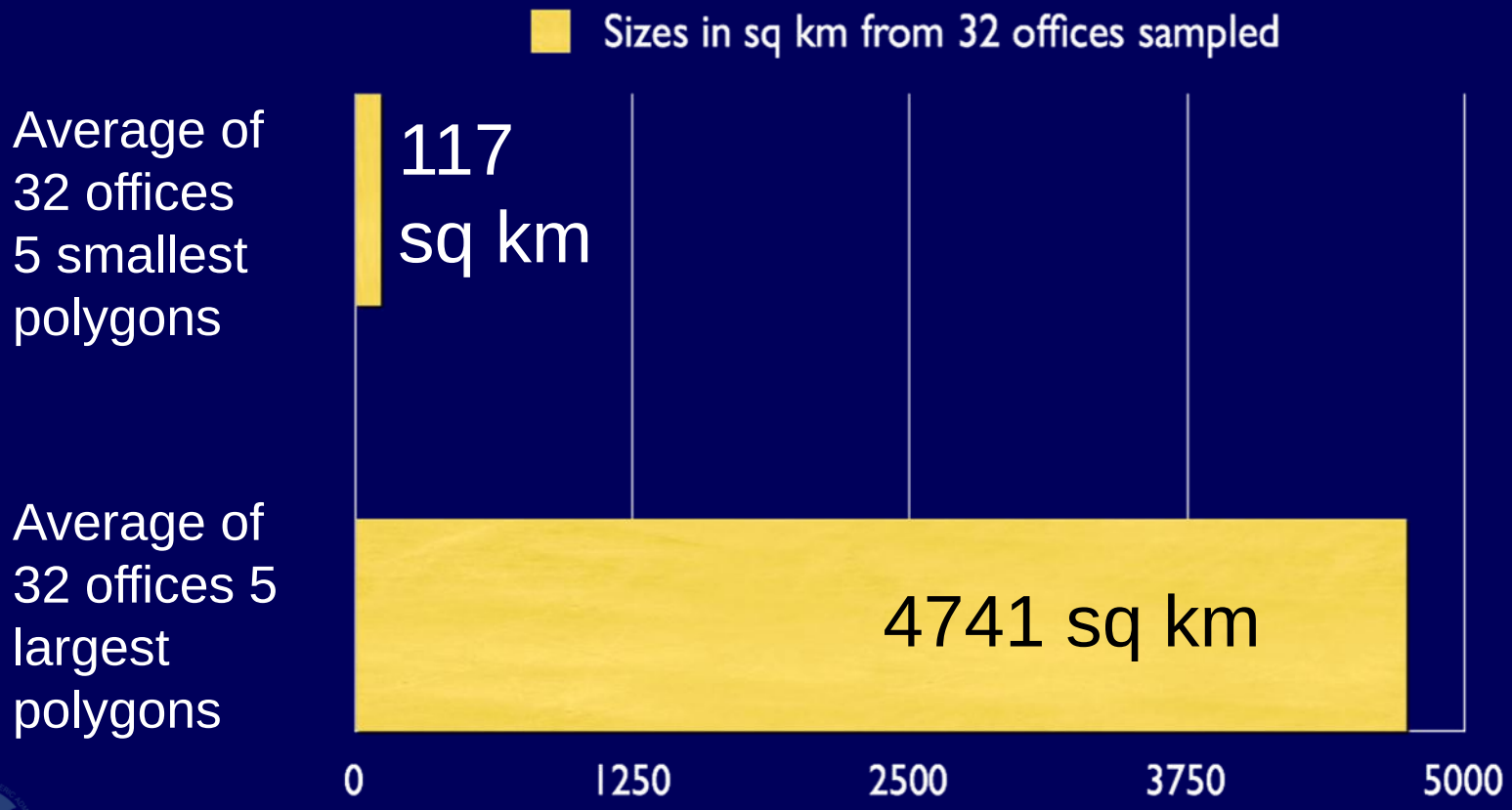
Top 10 Smallest for WFO: ALL

Date Issued	Size (sq km)	WFO	Phenomena
2009-03-29	3.54	MHX	Tornado Warning 6
2008-09-10	14.58	KEY	Tornado Warning 15
2011-08-18	16.90	ILM	Tornado Warning 28
2011-08-18	19.47	ILM	Tornado Warning 27
2008-09-01	20.25	TAE	Tornado Warning 58
2011-07-11	22.57	MPX	Tornado Warning 34
2011-05-18	29.96	LWX	Tornado Warning 60
2009-09-12	31.55	LIX	Tornado Warning 50
2008-09-10	33.08	KEY	Tornado Warning 14
2008-04-20	33.25	GSP	Tornado Warning 19

Averaged smallest 5 TOR polygons from 32 WFO's sampled

Tornado Warning Polygon size findings

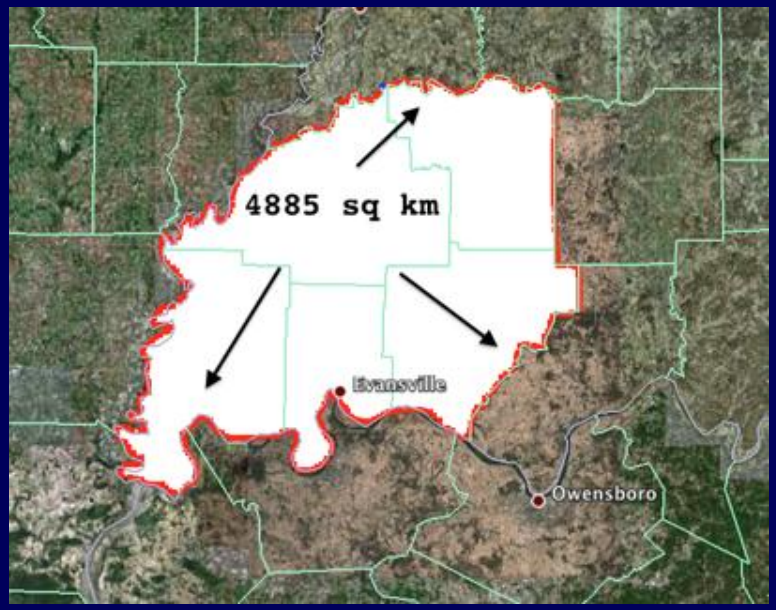
Fact: Of the 32 WFO's sampled, 24 offices (or 75%) have seen an increase in their office's average Tornado Warning Polygon size since Oct 1, 2007.



Visualizing the discrepancy between the smallest and largest polygons we issue

So what is the difference, geographically between 117 sq km and 4741 sq km?

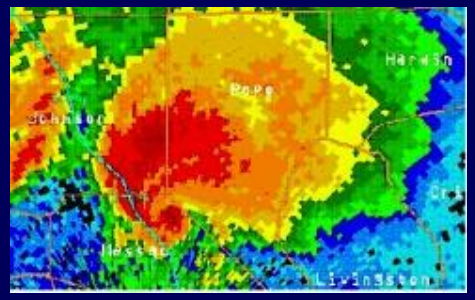
City of Evansville
105 sq km

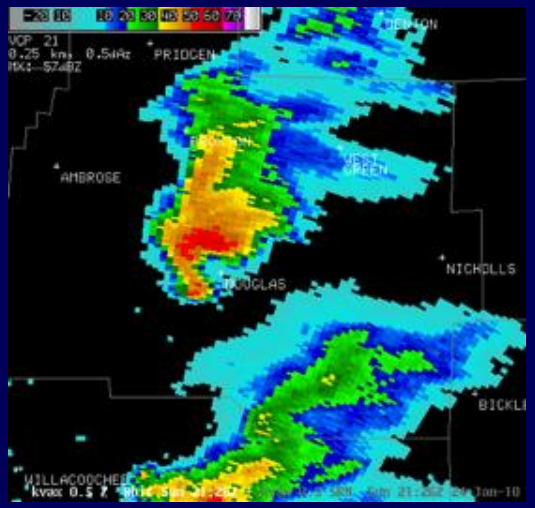


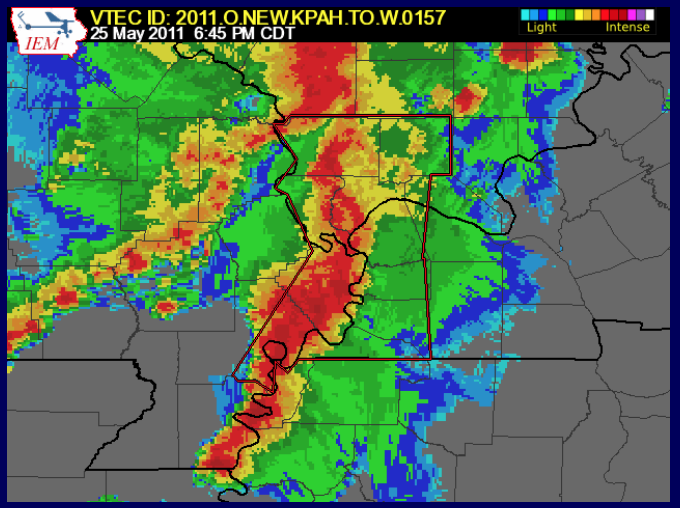
Gibson, Pike, Posey, Vanderburgh and Warrick counties equal 4885 sq km

Reason for size variations

Storm structures and evolution both factor heavily into resultant polygon sizes. 3 good examples are HP Supercells, mini Supercells, and QLCS structures.

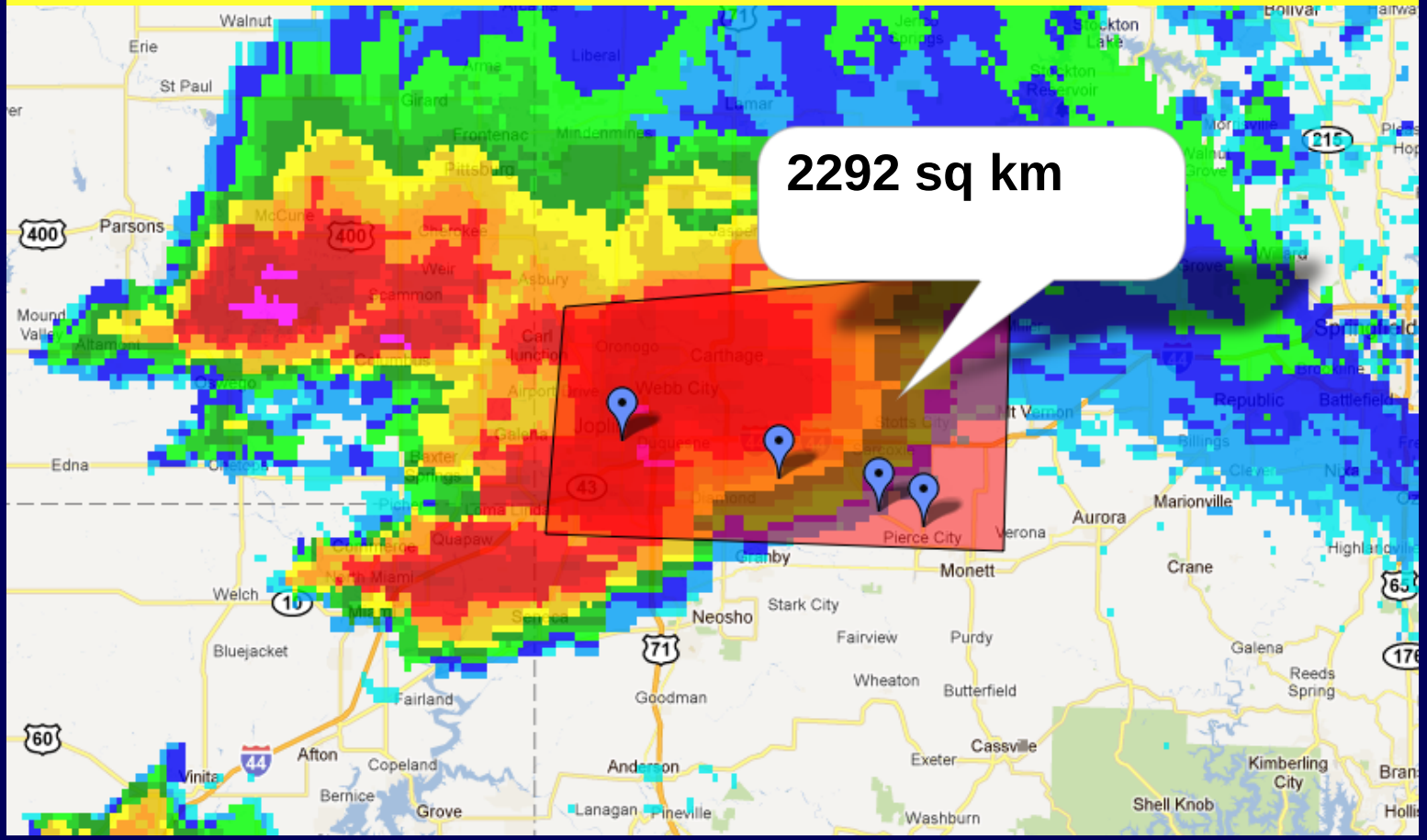




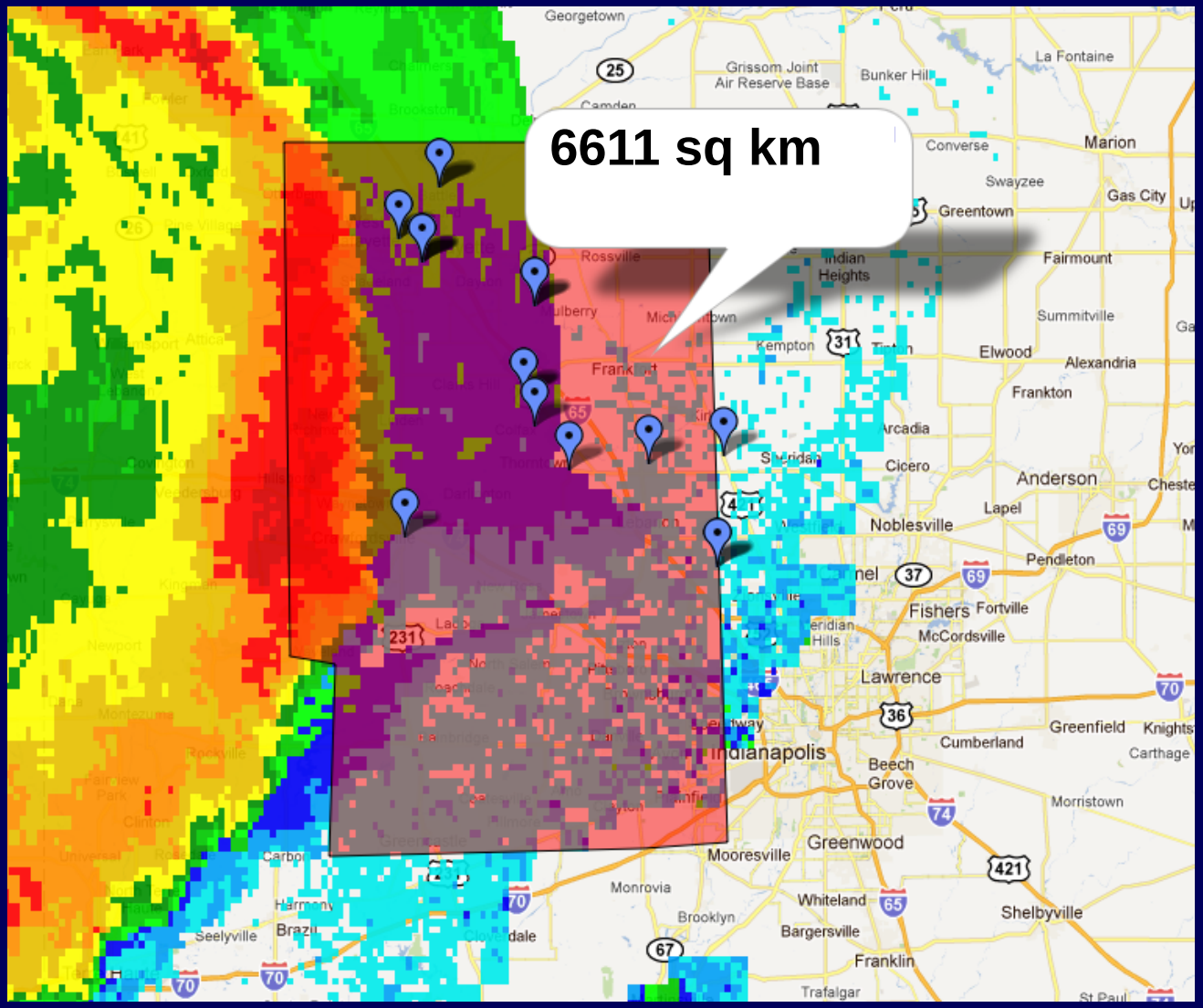


Typical Tornado Warning Polygon Sizes?

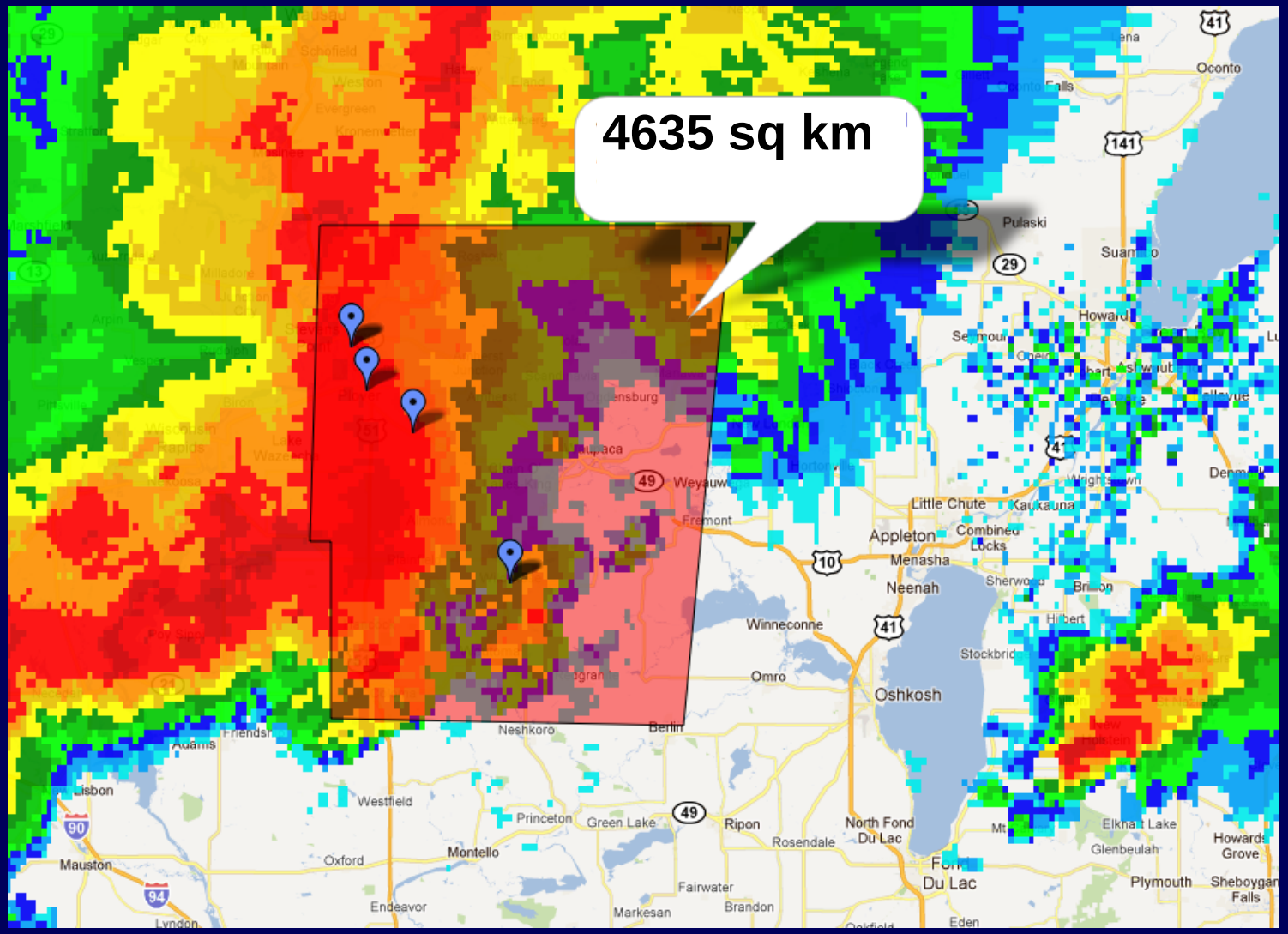
Joplin, MO Tornado - Warning Polygon



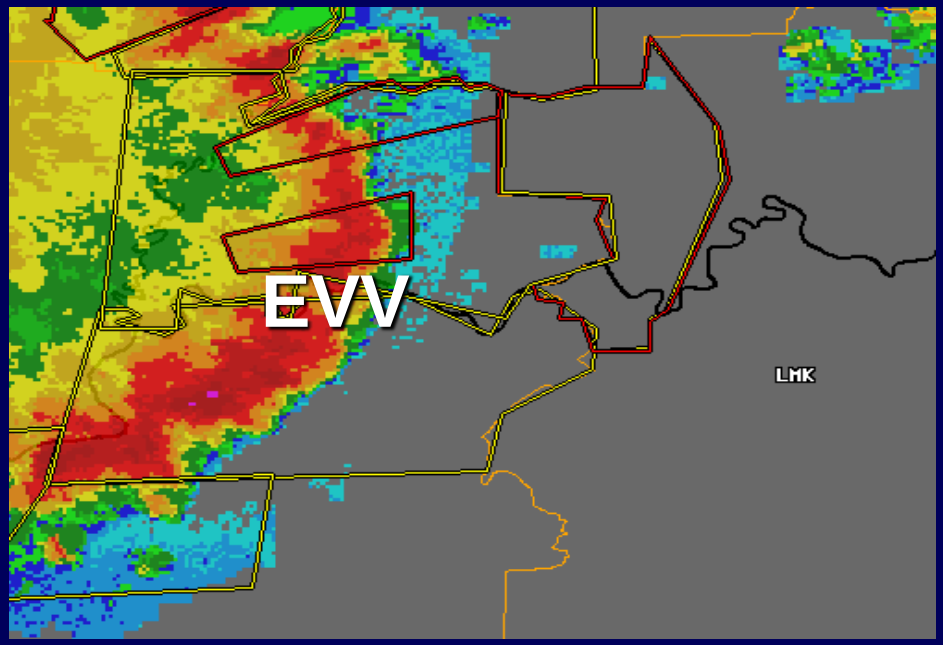
Large Tornado Warning Polygons for QLCS events - NW of Indianapolis



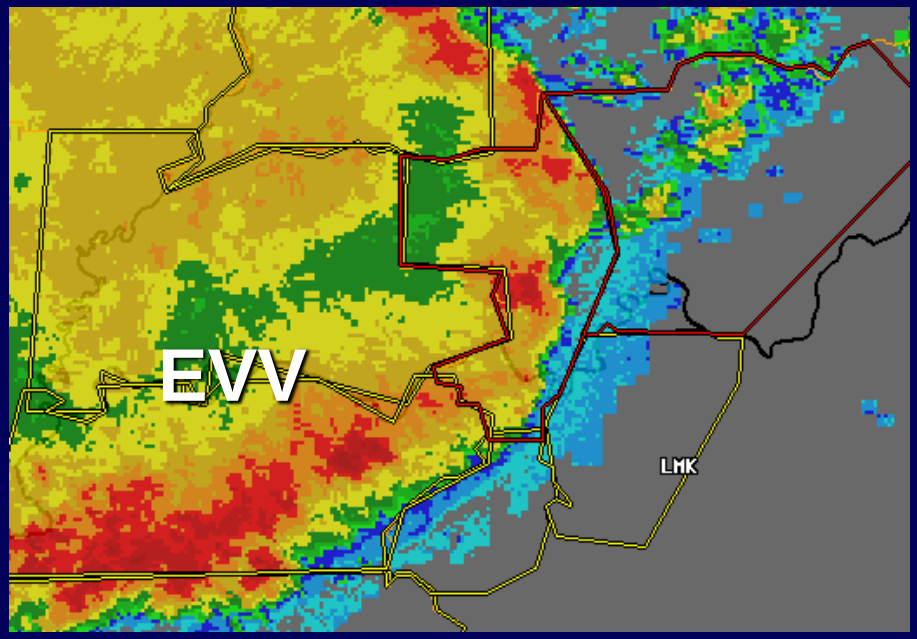
Large Tornado Warning Polygons for QLCS events - west of Green Bay, WI



Difference in Approach to TOR Warning Polygons



1000 PM 4/19/2011

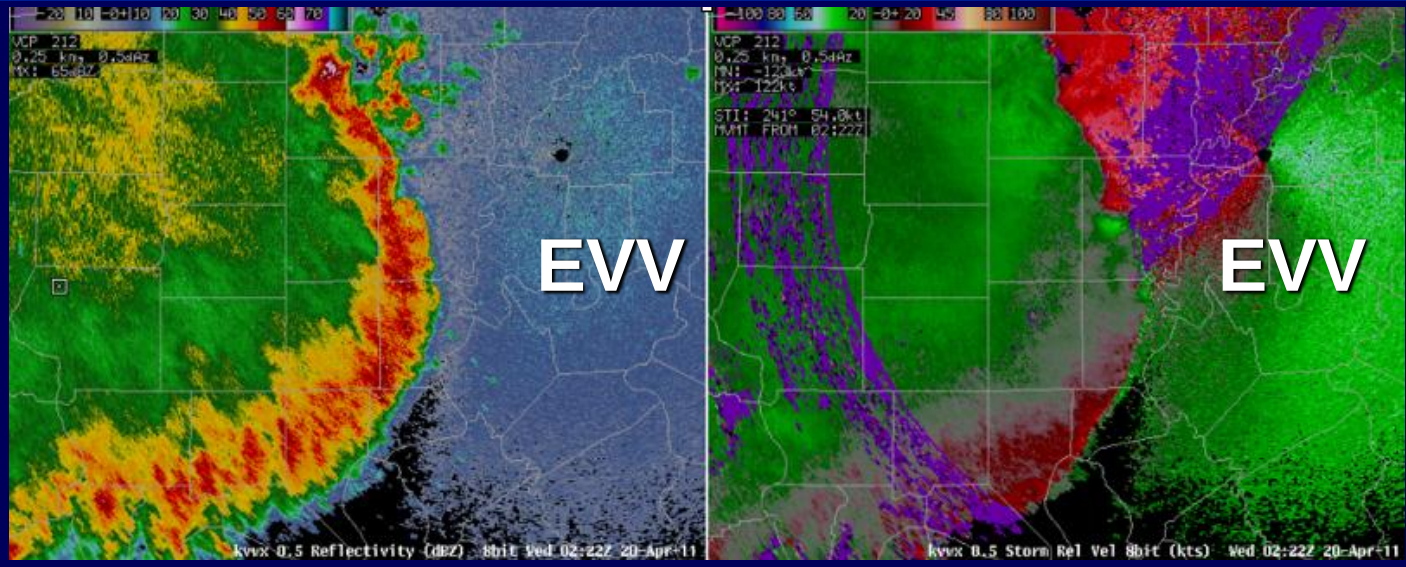


1040 PM 4/19/2011

Storms moving from SW Indiana into South Central Indiana

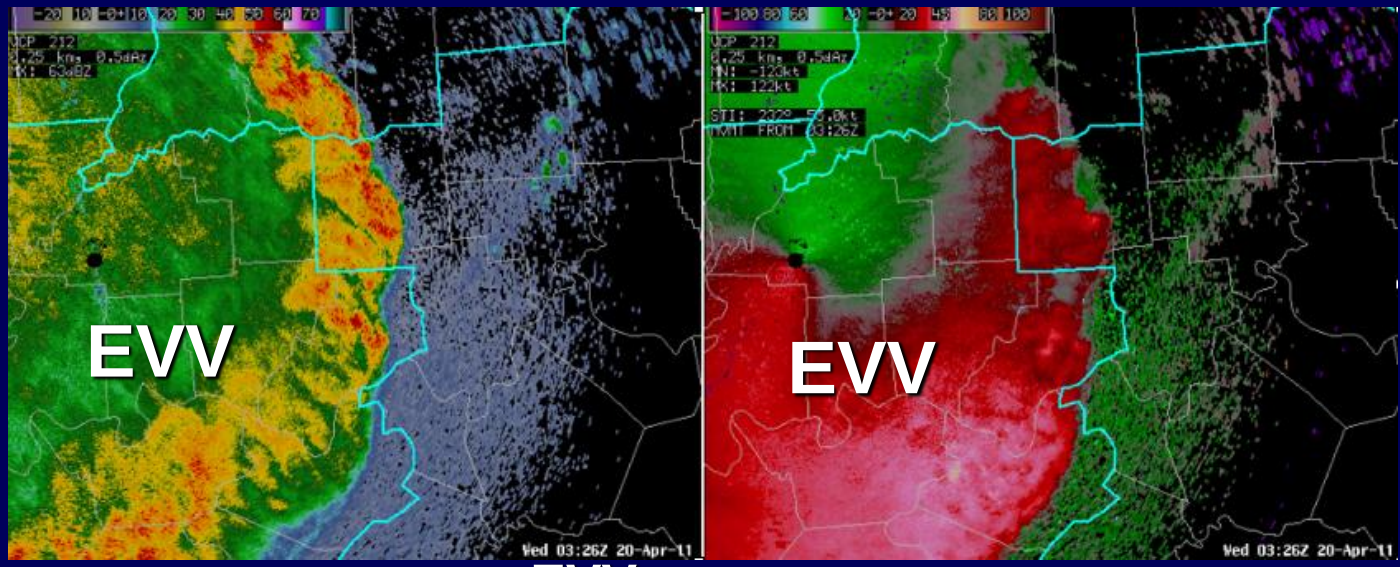
Mesovortices KVWX radar 4/19/11

Reflectivity/SRM data from KVWX at 922 p.m. CDT 4/19/11

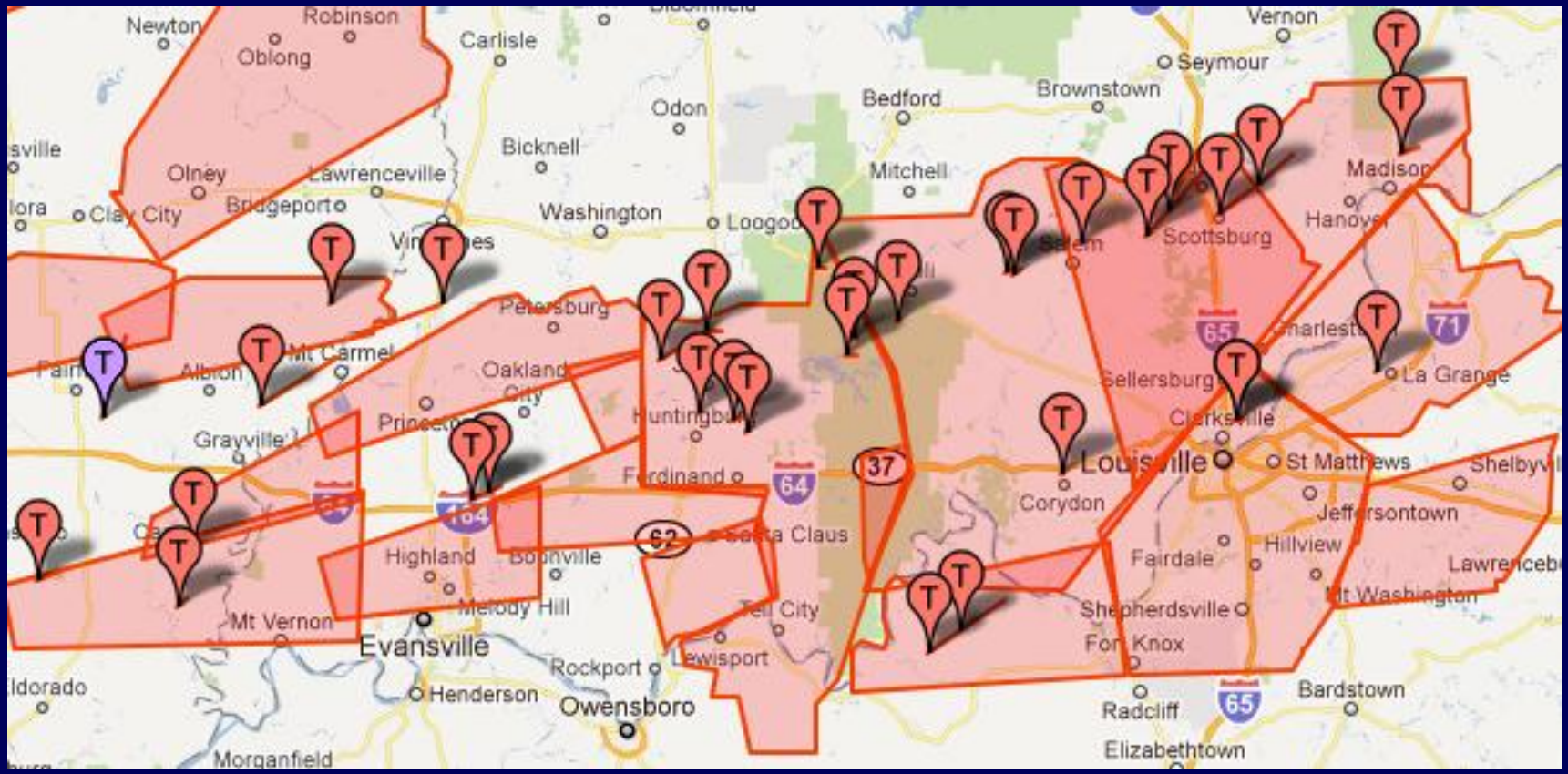


Relative to EVV (Evansville, IN Regional Airport)

Reflectivity/SRM data from KVWX at 1026 p.m. CDT 4/19/11



Severe events 4/19/11

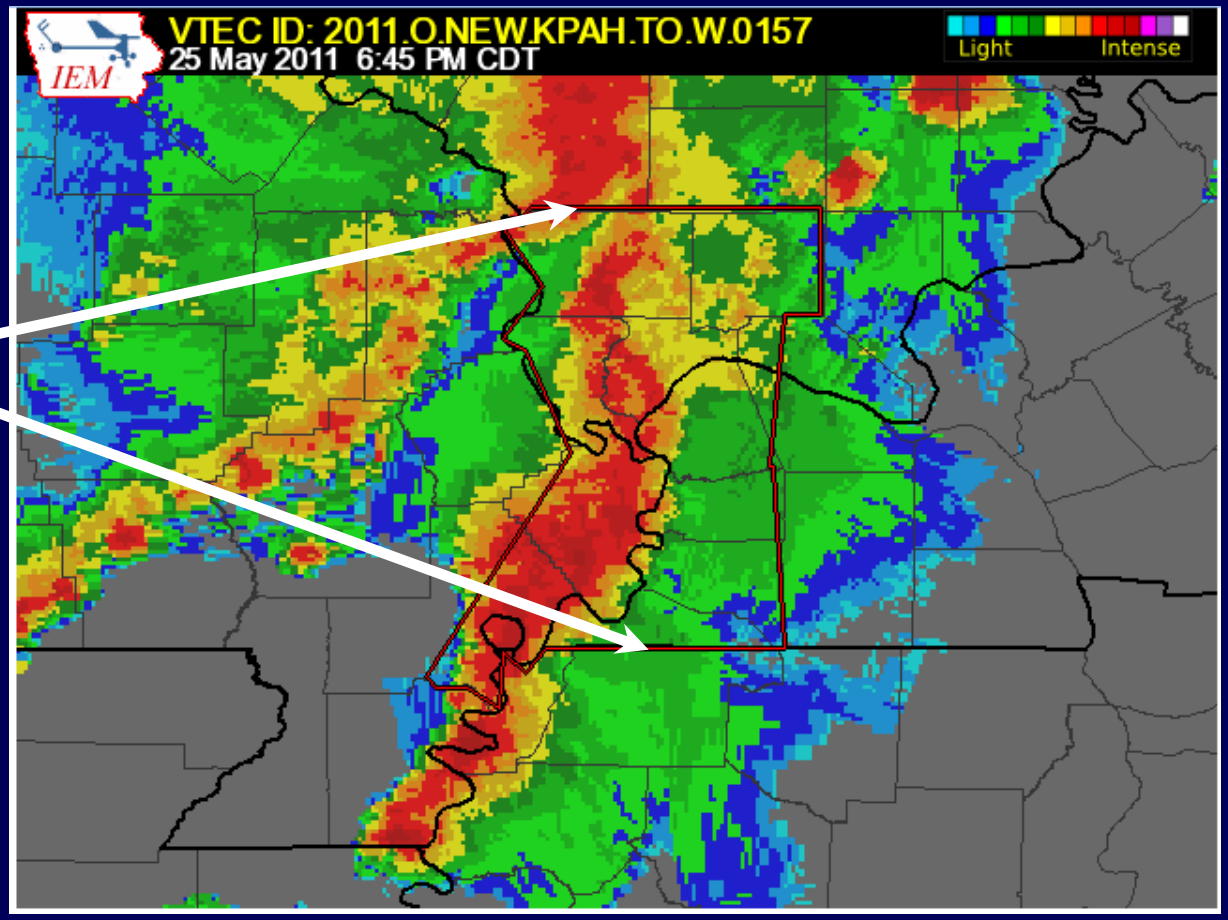


14 EF0's – 0 deaths, 0 injuries
12 EF1's – 0 deaths, 0 injuries
5 EF2's – 0 deaths, 2 injuries

Large polygon May 2011

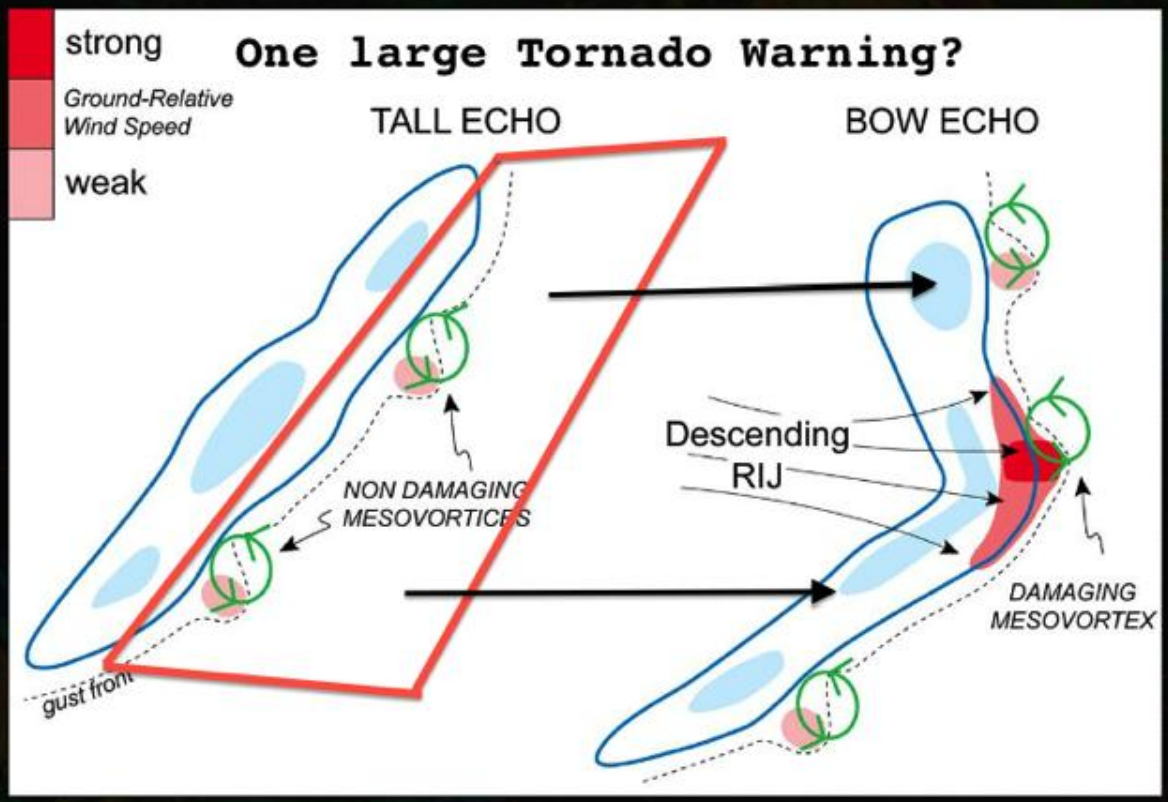
Warning Polygon over 7500 sq km in size

"When I saw this Tornado Warning Polygon, I thought of the 2009 Ice Storm, and that damage could be substantial" – Principal, Lone Oak Elementary School



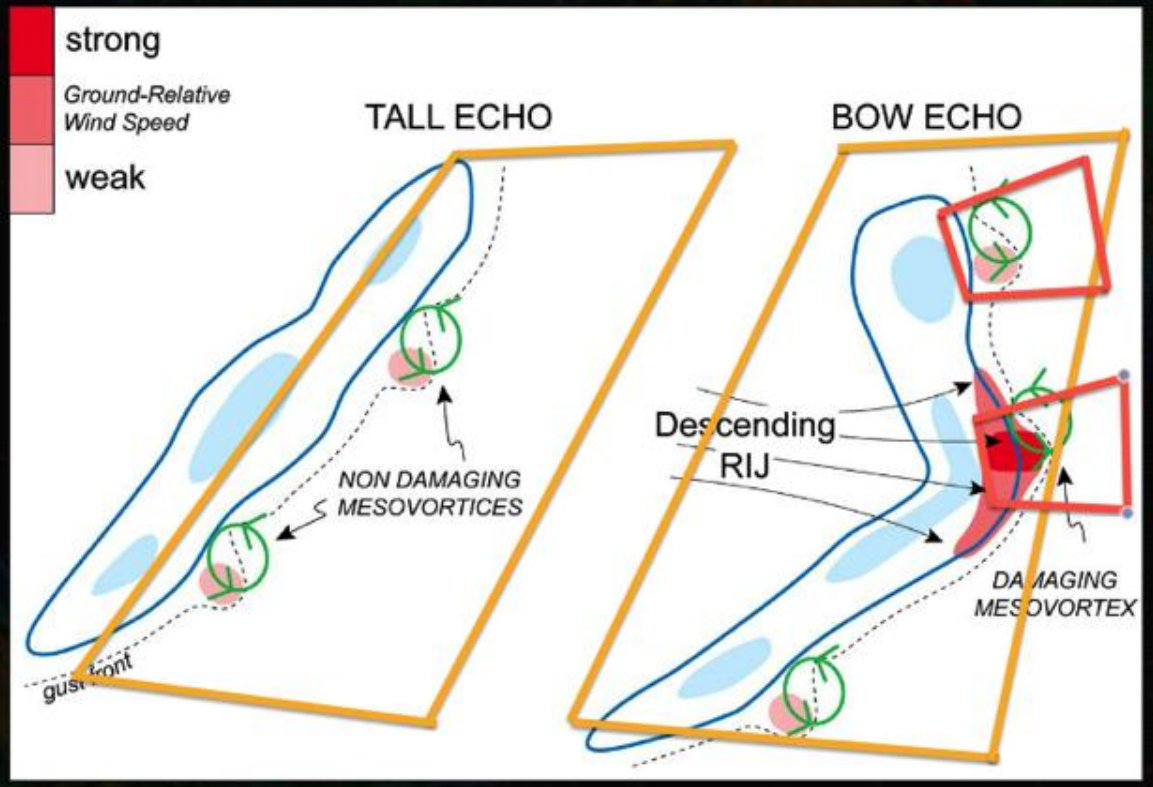
Should we do this?

Initial stage of a damaging bow echo



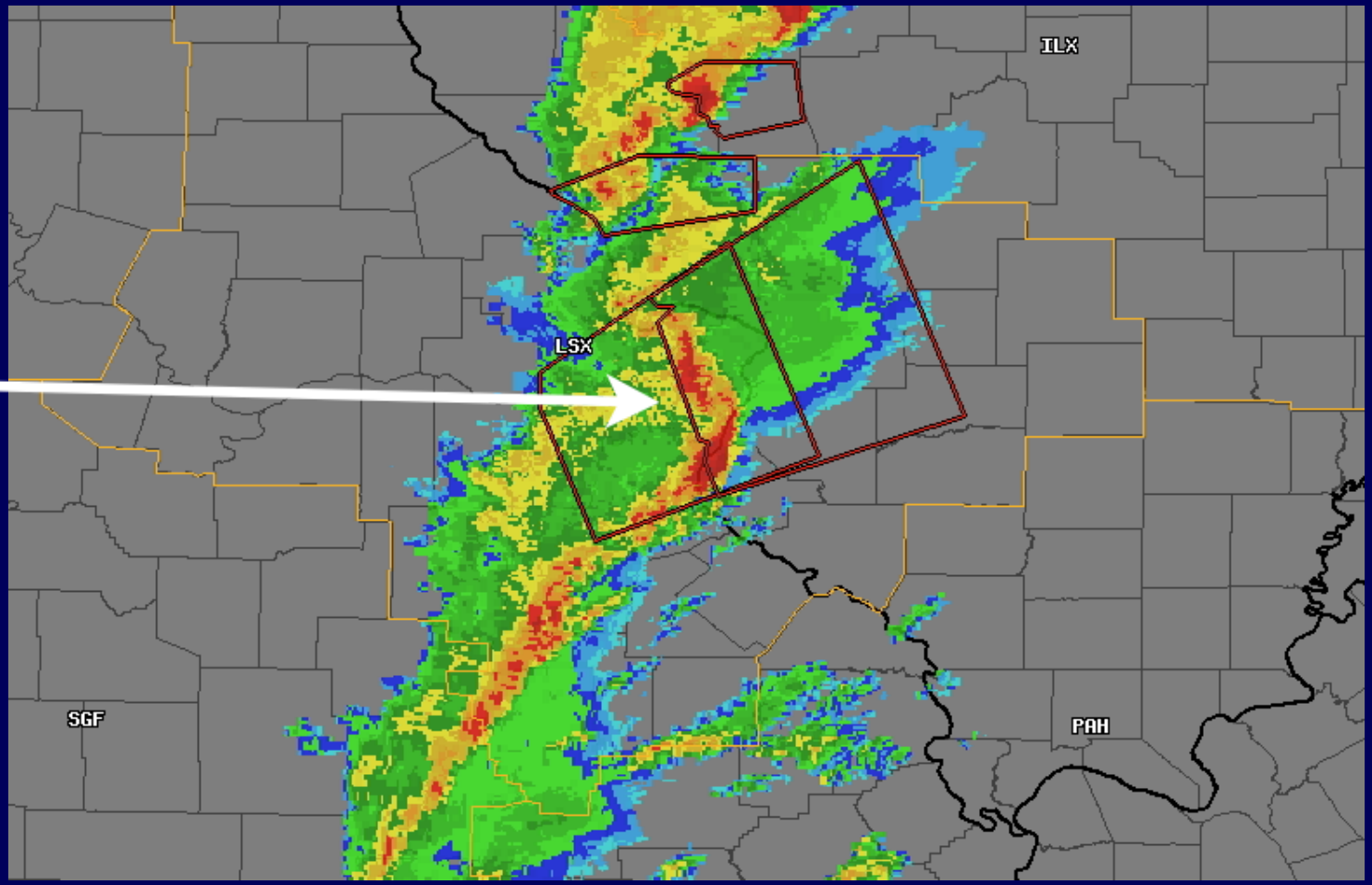
Is this a better approach? SVRs first with enhanced wording initially, then TORs

Initial stage of a damaging bow echo



Examples from Dec. 31st 2010 Tornado Outbreak

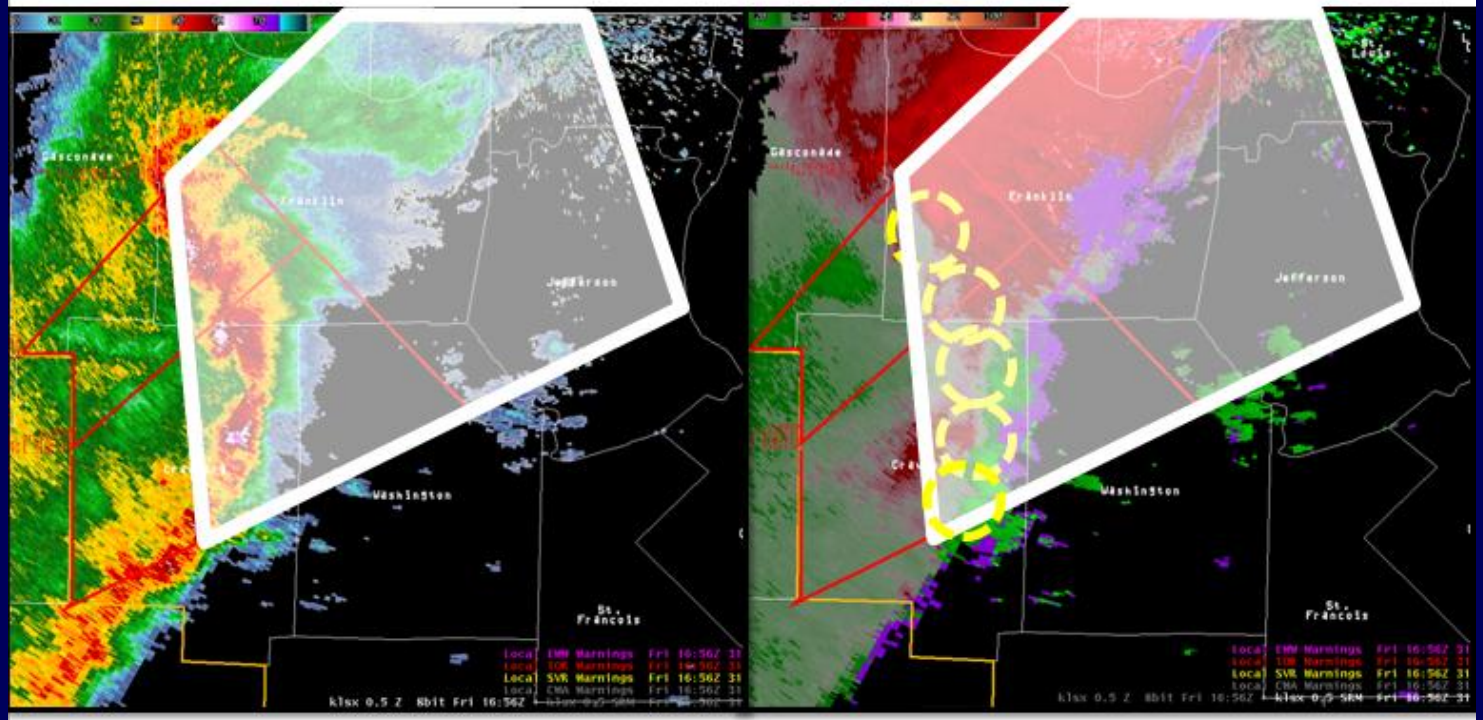
Up to 9 mesovortices were observed in this QLCS - Substantial tornadic damage (up to EF3)



Boxology with numerous Mesovortices
New Years Eve 2010 – Jim Sieveking
(WFO St. Louis)

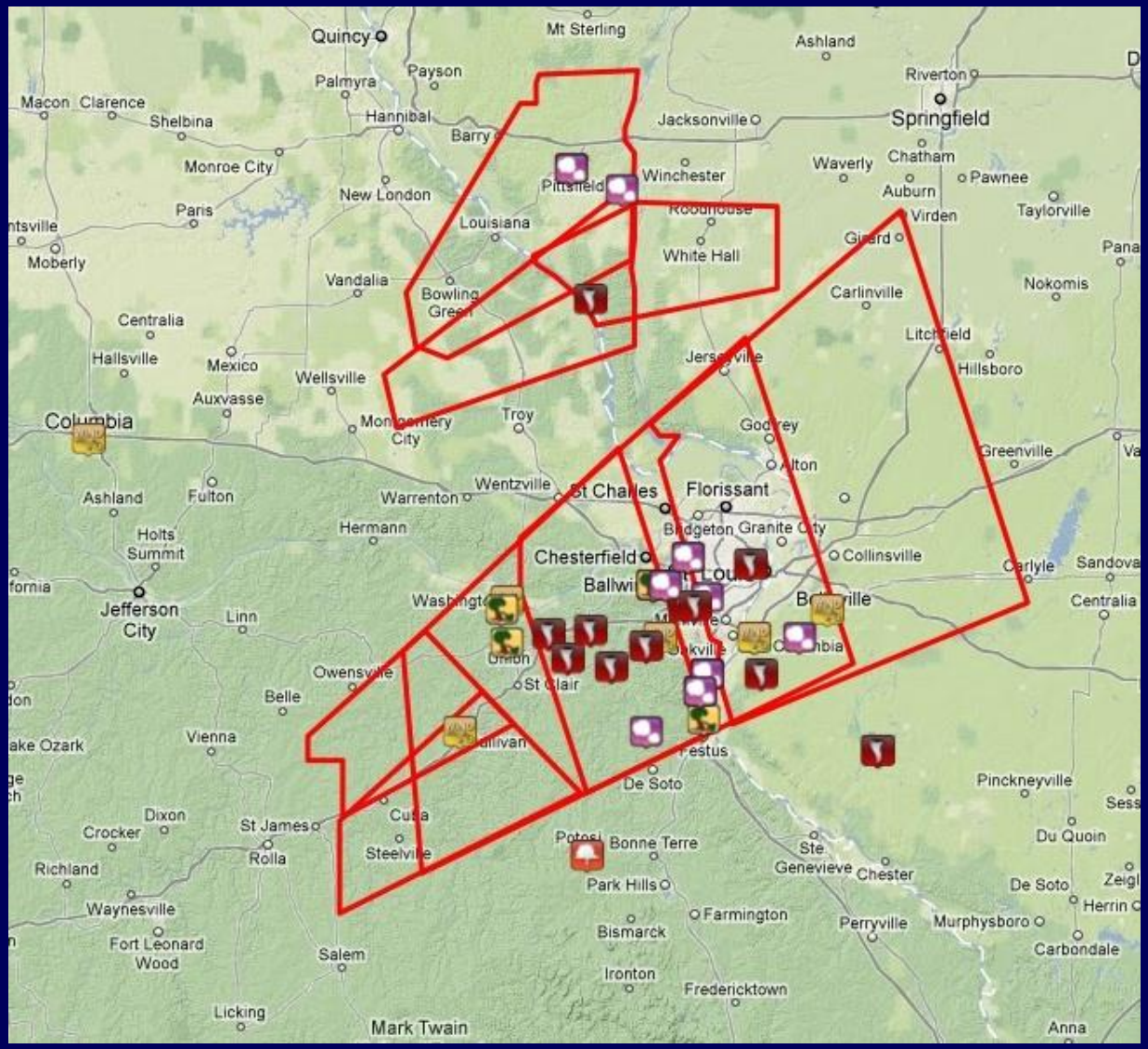
Warning Decisions

Boxology= Large Tornado Warning Polygon



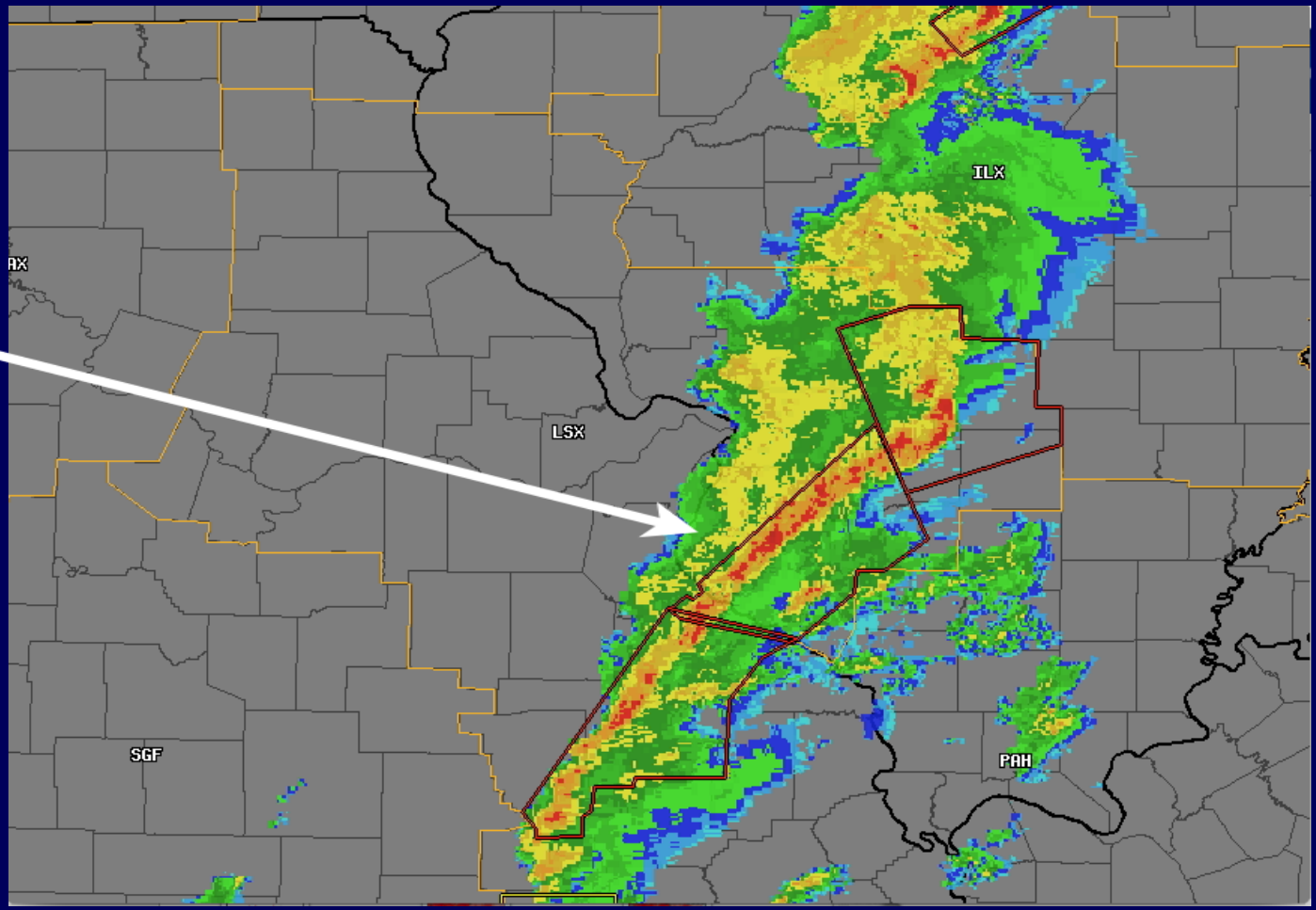
16:56 UTC

Severe Events 12/13/2010 – late morning through early afternoon



Examples from Dec. 31st 2010 Tornado Outbreak

Later as the line continued east, it weakened, but large TOR polygons continued, 3 adjacent polygons over 100 miles in length



Media Feedback – TV Media in Paducah's CWA

*-"**We are very concerned about the larger polygons issued** to try and capture the weaker tornadoes with QLCS events. It **makes my job very difficult** when trying to pinpoint the actual threat areas, and explain why the warning is in effect for the ENTIRE area"*

*-"I feel we are relaying **too many Tornado Warnings** that never produce tornadoes."*

*-"My station manager wants me to stay on the air for the duration of Tornado Warnings. **The more warnings and false alarms, the more upset viewers become**."*

Partner and User Feedback

McCracken County Schools:

- They treat all Tornado Warnings for McCracken County the same, regardless of the basis for the warning and/or polygon size.
- **8000** people are affected when you count students, staff and bus drivers.

Western Baptist Hospital:

- They react to ALL Tornado Warnings for any part of McCracken County the same regardless of the basis of the warning, and/or polygon size.
- Warning response time, getting staff, visitors and patients to safety can take 8 to 16 minutes depending on preparation. Usually the number of people that will be directed to shelter ranges from **1500** to **1800** on a given day.

Partner and User Feedback

Toyota Plant in Gibson, County Indiana:

- Cost to shut down operations for a Tornado Warning is about 10,000 dollars per minute.
- When a warning is issued, it is broadcast on portable radios supervisors carry. **If radar indicated, they do not take shelter**.

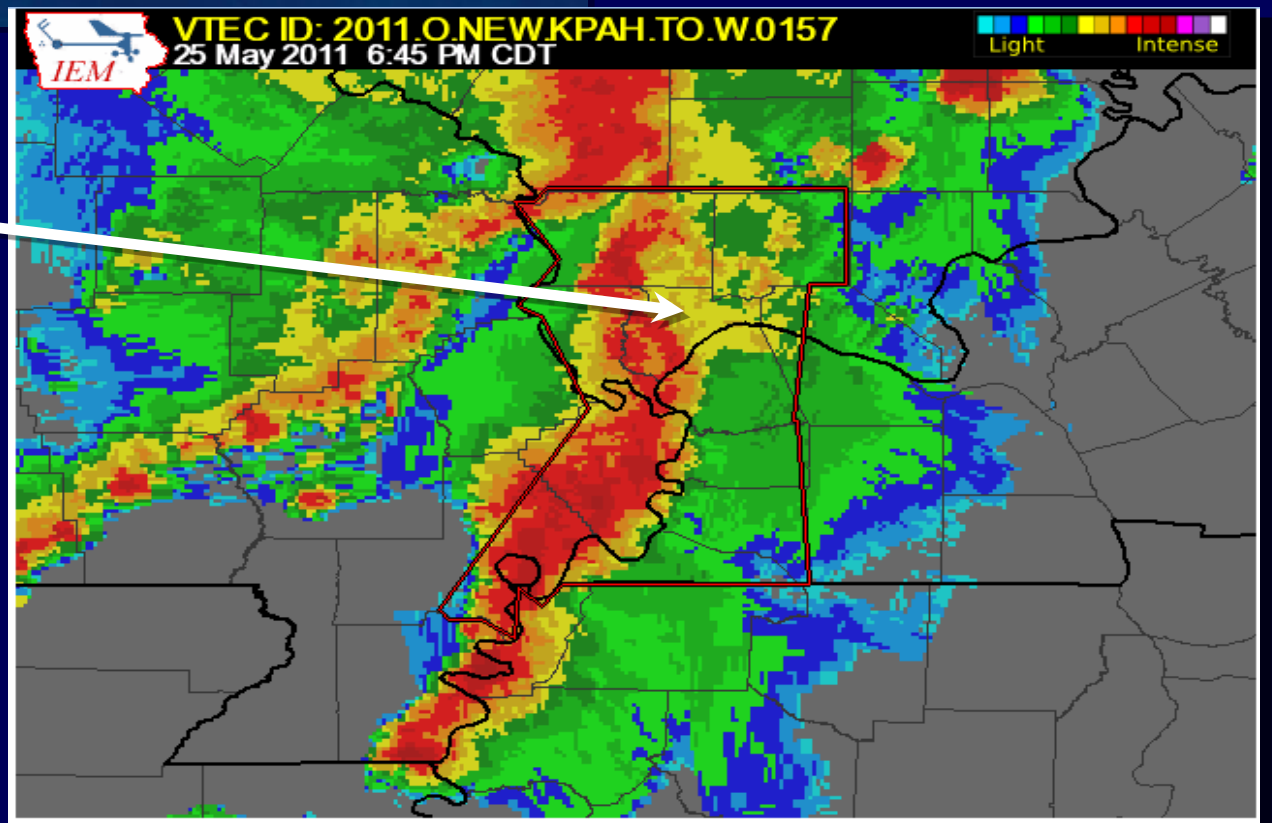
Lowe's Paducah, KY stores:

- Building is locked down. Nobody in or out when a Tornado Warning is issued.
- They react to ALL Tornado Warnings for any portion of McCracken County the same, regardless of the basis for the warning and/or size of the polygon.
- Will react when they hear the sirens.

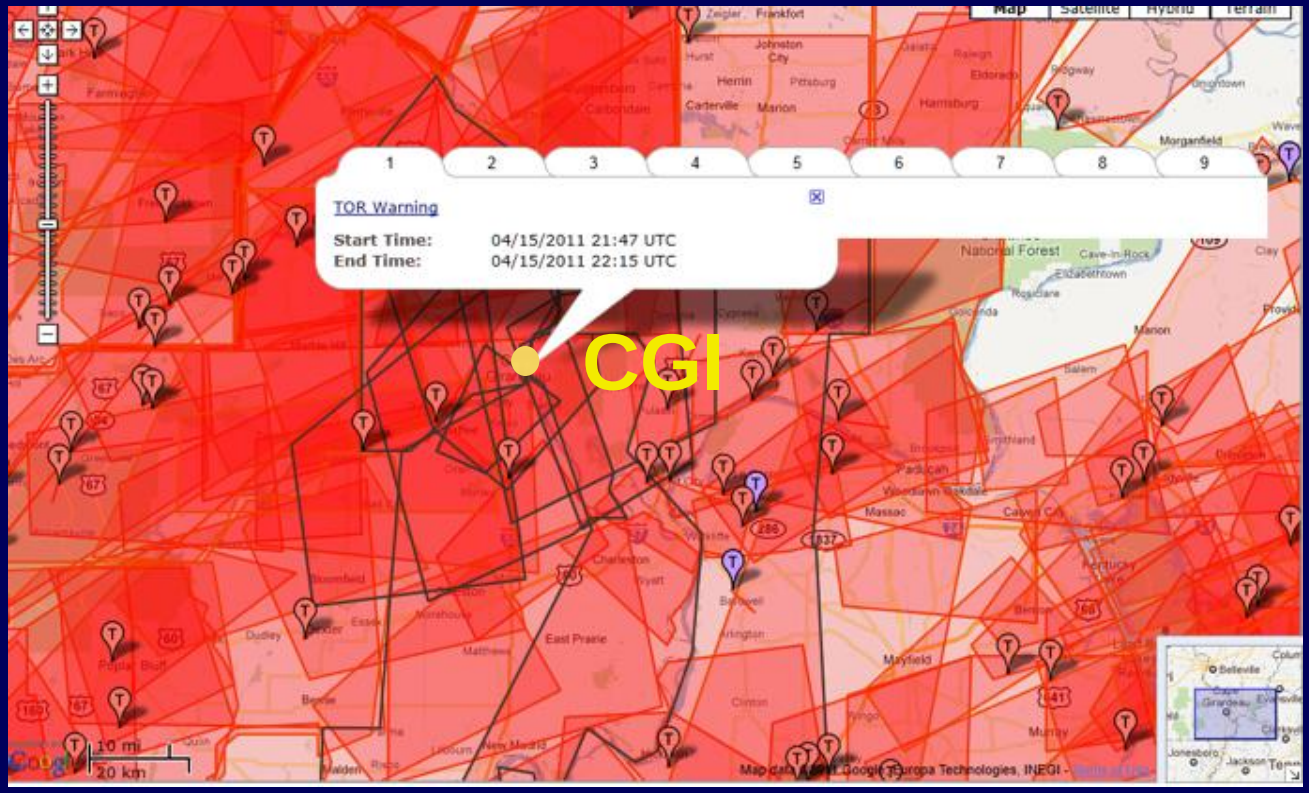
Warning Rationale - from WDTB Training

- Minimize false-alarm area
- Cost savings of fewer people taking shelter unnecessarily
- Advantages of GIS tools
- Improved graphical presentations

Does this polygon follow the above rationale?



Tornado Warning Polygon Overlay WFO PAH CWA



Tornado Warning polygons covering Cape Girardeau, MO population 37,941 (63 sq km), this year (2011)

NWS Warning Forecasters Understanding...

NWS Warning Forecasters should have a good understanding of what plans of action and ICS decision support services are put into motion by our partners and users, when issuing a Tornado Warning.

Initial Proposal

Wording adjustments in Severe Thunderstorm Warnings...

- Use greater discretion when issuing Tornado Warnings for QLCS events. Avoid blanket warning with “safe” polygons.

- We are not suggesting our office will hold on a Tornado Warning, if one is warranted. We will simply use greater discretion during low confidence and / or weaker events. We will make a concerted to hone in on and define true threat areas.

- Unusually intense QLCS events may require a larger Tornado Warning polygon (refer to the LSX example from New Years Eve, 2010). These intense events are usually the exception, and not the rule.

Proposed Enhanced Severe Thunderstorm Warning for handling QLCS events

* AT 652 PM CDT...National Weather Service Doppler radar indicated a line of severe thunderstorms capable of producing destructive winds in excessive 70 mph.....

This line of severe thunderstorms may produce brief tornadoes with little or no advance warning.

* LOCATIONS IN THE WARNED AREA INCLUDE...
  CADIZ...CANTON AND COBB.

Also, reconsider the use of lengthy basis statements for QLCS tornadic events

Avoid lengthy and potentially confusing basis statements for Tornado Warnings. The public may not understand, or care about brief rain wrapped tornadoes.

Within a Tornado WARNING, instead of this…(25 WORDS AS A BASIS)

* AT 140 PM CST…National Weather Service Doppler radar indicated a severe squall line capable of producing brief rain-wrapped tornadoes in addition to widespread straight line wind damage.

Use…(15 WORDS AS A BASIS) move wind damage wording text down

* AT 140 PM CST…Radar indicated a line of severe thunderstorms capable of brief tornadoes and widespread wind damage.

The key selling point for the greater utilization of Severe Thunderstorm Warnings during QLCS events...

- Users and partners ARE using Severe Thunderstorm Warnings
- Partners and users understand severe storms can produces tornadoes with little or no advance warning.
- Both media and users support the idea of an enhanced severe thunderstorm warning vs. blanket events during low confidence and low to moderate impact events.
- Media has expressed support in the arena of public education – to convey the potential for brief, weaker, short lived tornadoes during a severe thunderstorm warning.

Acknowledgements

Thanks and credit go to the following for their professional expertise and support:

- Christine Wielgos - NWS Paducah, KY project assistant
- Dan McCarthy - MIC NWS Indianapolis, IN
- Wes Browning - MIC NWS St. Louis, MO
- Pete Wolf - SOO NWS Jacksonville, FL
- John Ferree - Severe Storms Services Leader OCWWS
- Ryan Presley, David Humphrey, Kevin Smith and Mike York - NWS Paducah, KY
- Sara Jupin - NWS Peachtree City, GA
- Shawn Weber - Storm spotter and NWS supporter
- Bob Reeves, Jeff Lyons, Wayne Hart, and Jim Rasor - regional TV meteorologists
- Participants in our surveys including Western Baptist Hospital, McCracken County Board of Education, Lowe's, Lourdes Hospital, Pulaski County, IL Emergency Management, the Department of Public Safety at Murray State University, and Toyota.
- NWS Paducah Management Team for their support and open minded approach to improving Tornado Warning Services.

References and data sources

- NWS Performance Management - Verification, including Storm Data
- Iowa State University Department of Agronomy - IEM Cow
- Databases from the Storm Prediction Center (SPC)
- Proposals for Changes in Severe Local Storm Warnings, Warning Criteria and Verification - Rogers Edwards
- Characteristics and Estimating Warning Success Rates of Significant Tornadoes from QLCS and Supercells in the Southeast U.S. - Nelson and Combs
- Tornado Trends Over the Past 30 Years - McCarthy and Schaefer
- Tornadoes without NWS Warning - Brotzge, and Erickson
- Environmental Factors and False Alarm Ratios of Tornadoes from QLCS and Supercells in the Southeast U.S. - Jupin
- Warning Decisions and Event Operations New Years Eve Tornado Outbreak - Sieveking